Health Risks Associated with Nurse Night Shift Work: A Systematic Review

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Abstract*—The purpose of this systematic review is to examine health risks associated with nurse shift work. An electronic literature search for "Health Risks Nurse Night Shift" was conducted using Pubmed, CINAHL, and Health Source: Nursing/Academic Edition databases. Inclusion criteria used was English language, full text available, and published dates between January 1, 2004 and March 1, 2015. Based on the search criteria a total of 90 articles were identified. Abstracts for the articles were reviewed for relevance and duplicate citations removed for a total of 33 articles being included in the review. Identified health risks associated with nurse night shift work included breast cancer, fractures, obesity, type 2 diabetes, menstrual irregularities, stroke, cardiovascular disease, irritable bowel syndrome, and depression. Rotating night shift work was associated with a decreased risk of developing Parkinson's disease and skin cancer. Future research should focus on effective interventions to decrease health risks associated with prolonged nurse night shift rotations.

***Keywords*—health risks, nurse, night shift**

I. Introduction

Many occupations require that employees work various shifts covering a 24 hour period during 7 days a week. This requirement to perform shift work is universal. Because patients requiring 24-hour care, hospitals require nurses to worked shifts. Research studies on the health risks associated with shiftwork are published throughout the world. Many of these studies focus on sleep disorders and quality of life issues, but there is a growing body of research investigating potential health risks associated with shift work. In fact, there may be even more areas of health risks for nurses who work prolonged night shifts and those who work rapidly rotating shift work. The purpose of this systematic review is to identify health risks associated with nurses' night shift work.

II. Method

An electronic literature search for "Health Risks Nurse Night Shift" was conducted using the Pubmed, CINAHL and Health Source: Nursing/Academic Edition databases. Inclusion criteria included English language, human studies, full text available articles, and published dates between January 1, 2004 and March 1, 2015. Based on the search criteria a total of 90 articles were identified. Abstracts for the identified articles were reviewed for relevance and duplicate citations were removed. Reference lists were also reviewed for relevancy, resulting in a total of 33 articles being included in the systematic review. Over one half of these articles referenced an analysis of data collected during one of the Nurses' Health Studies. The data was analyzed using multivariate Cox proportional hazard models adjusted for demographic characteristics and risk factors.

The studies utilizing data from the Nurses' Health Studies examined the association of shift work with risk of breast cancer [1], type 2 diabetes [2, 3], lung cancer [4], skin cancer [5], endometriosis [6], endometrial cancer [7], menstrual irregularities [8, 9], stroke [10], telomere length [11], ovarian cancer [12], fractures [13], Parkinson's disease [14], cognitive functioning [15], hypertension [16], cause specific mortality [17], cardiovascular and cancer [18], and urinary melatonin concentration [19]. The other studies included in the review utilized data outside the Nurses' Health Studies.

III. Analysis

The quality of studies were assessed using STROBE checklist criteria for observational, cohort, case control, and cross-sectional studies [20]. The systematic review studies were evaluated for quality factors utilizing the PRISMA Checklist [21]. Most of the studies reflected a high level of quality. However, no studies were eliminated from the review based on quality factors.

The analysis of the articles will begin by discussing outcomes from the 19 cohort studies discovered that utilized the Nurses' Health Studies data. The analysis for these studies included methods to adjust for potential confounding variables. The findings from two studies indicate that there is a modest elevated risk of breast cancer related to longer periods of rotating shifts. This risk increases with the number of years of shift work [1]. Several of the studies commented on the increased risk of obesity for working night shift or night shift rotations [2, 10]. Two studies supported that rotating night shift is associated with an increased risk of Type II diabetes [2, 3]. However, when weight is eliminated as a confounding variable, the association of diabetes with night shift rotation is no longer significant in one of the two studies [2]. Two additional studies concluded that night work was positively associated with menstrual irregularities [8, 9]. In addition, long term shift work of 15 or more years was associated with an increased risk of stroke [10], fracture [13] and lung cancer [4]. Current smokers with 15 or more years of

DOI: 10.5176/2010-4804_2.2.74

rotating night –shift work was associated with a 61% increased risk of lung cancer (P trend= 0.0006). When smokers were eliminated as a potential confounding variable, lung cancer rates were no longer significant in never smokers who worked night shifts in one of the two studies [4]. Women who worked 20+ years of nightshift work was associated with an increased risk of wrist and hip fractures over 8 years of follow-up compared to women who never worked night shift. During the 12 year follow-up, the initial findings regarding fracture risks were no longer present [13]. Another study looked at the mortality causes for women working rotating shifts. The study concluded that women working rotating night shift for 5 or more years have an increase in mortality related to cardiovascular disease and all-causes [18]. Gangwisch and others (2013) discovered that women under the age of 50 years old who slept 5 or fewer hours a day had an increased risk of developing hypertension [16]. The authors also noted that women with short sleep durations were more likely to have diabetes, have a BMI equal to or above 30, and be a shift worker. Lie and others (2012), further examined the relationship between shift work and hypertension. The authors discovered that rotating night shift is independently associated with race as a risk factor for hypertension. They concluded that black nurses had an increased risk of hypertension when working shift work, but white nurses did not have any increased risk of hypertension related to shift work [15].

There were five studies utilizing data from the Nurse' Health Study that did not find any significant relationship between night shift work and specific health risks. These studies concluded that shift work is not associated with an increased health risk for endometriosis [7], ovarian cancer [12], telomere length [11], urinary melatonin [19], or cognitive functioning [15]. Telomere length has been proposed as a possible marker for aging, but the study did not show any relationship between telomere length and shift work [11]. Urinary melatonin has been proposed as having a protective role in breast cancer etiology. The study concluded that there were no associations between urinary melatonin concentration and breast cancer risk [19].

Two of the studies utilizing data from the Nurses' Health Study concluded that shift work may actually reduce the health risk for skin cancer and for developing Parkinson's disease [5, 13]. The highest reduction in skin cancer risk (44%) was for women who worked night shifts for 10 or more years [5].

There is a growing evidence of knowledge that working night shifts for extended periods of time may place female nurses at increased risk for breast cancer. Several meta-analysis and systemic reviews of the data have been published with some conflicting conclusions. Megdal and others (2005) conducted a systematic review and meta-analysis based on 13 studies identified on MEDLINE between January 1960 and January 2005 that involved night work and breast cancer risk. Only observational studies that studied any type of night shift work and breast cancer risks were included in the review. The investigators analyzed 7 studies of airline cabin crew from Norwegian, California, Iceland, Finland, Swedish Scandinavian, Denmark and US Airlines. In addition, they reviewed 6 more studies involving other night shift workers. Three of these studies involved nurses as subjects. The investigators ran Egger's and Begg and Mazumdar's tests for publication bias and results indicated significant symmetry ($p>0.05$). In pooled results, author found a statistically significant 48% increase in risk of breast cancer among shift workers. Separate analyses of both shift workers excluding flight attendants yielded virtually identical results. The authors concluded that studies on night shift work and breast cancer risk collectively shown an increase in breast cancer risk among women. They also stated that publication bias is unlikely to have influenced results [22].

Similar results on risk of breast cancer were found in a case-control study of shift work and breast cancer risk in Danish nurses [23]. Hansen & Stevens (2011) utilized the data from the National cohort longitudinal study of 91,140 members of the Danish Nurses Association. The sample consisted of 58,091 female members alive on July 1, 2001, free of breast cancer, and born between 1933 and 1970. Out of this sample there were 310 cases of histologically confirmed primary breast cancer that were documented between July 2001 and July 2003. The researchers completed interviews on 267 patients and 1035 controls. The investigators estimated relative risks as odds rations with 95% confidence intervals by multiple logistic regression analyses. All models were conditional on 5-year age groups. The findings supported that nurses who worked rotating shifts after midnight had a significantly increased odds ratio for breast cancer compared to nurses with permanent day work. The highest odds ratio was observed for long-term day-night rotating shifts. Rotating day/night shifts may be more disruptive than working straight night shifts. In addition, nurses working night shifts reported more menstrual irregularity than those working days. Other trends included: nurses working grave yard shift had significantly longer working life, younger at menarche and menopause, had fewer children, were older at birth of their first child, spent fewer hours weekly on sport, slept fewer hours per night and were more frequently exposed to electromagnetic fields [23].

On the other hand, Ijax and others (2013) conducted a systematic review and meta-analysis of shift work and breast cancer, but came up with different conclusions. The researchers examined 16 studies (12 case-control and 4 cohort studies). They assessed risk of bias for each study as low, high or unclear by using a validated checklist for measuring bias in studies of risk factors. There was a 9% risk increase per five years of night-shift work exposure in case-control studies but not in cohort studies. Based on the low quality of exposure data and the difference in effect by study design, the findings indicate insufficient evidence for a link between night-shift work and breast cancer [24].

Kamdar and others (2013) analyzed 15 observational case-control and cohort studies examining the association between night-shift work and breast carcinogenesis published before March 1, 2012. The systematic review and meta-analysis questions the findings of previous studies because of "unmeasured confounding". The authors concluded that there is weak evidence to support previous reports that night-shift work is associated with increased breast cancer risk [25].

In addition, Kolstad (2008) investigated the epidemiologic evidence for a relationship between nightshift

work and risk of breast cancer and other cancers. Kolstad conducted a systematic review with articles up to May 2007 in Pubmed. From his literature search, he identified 13 relevant epidemiological reports found during the literature search (8 breast cancer, 3 prostate cancer, 3 colon cancer, and 4 including all cancers). In 5 of the 8 studies on breast cancer in women indicated an increased risks associated with night shift work. In 3 of the 5 studies on breast cancer, findings suggest a significant increased risks after 20-30 years of night shift work. The author concluded that there is insufficient evidence for a causal association with prostate, colon or overall cancer cases with night shift work [26].

Wang and others (2011) conducted a systematic review of the epidemiological evidence of shift work and chronic disease. The authors searched PubMed for applicable articles published prior to December 31, 2009. A total of 29 studies (6 related to cancer and 23 related to cardiovascular disease and related chronic conditions) were selected for inclusion in the review. Authors concluded published evidence is suggestive but not conclusive for an adverse association between night work and breast cancer, but limited and inconsistent for cancers at other sites and all cancers combined. Findings on shift work in relation to risks of CVD, metabolic syndrome and diabetes are also suggestive but not conclusive for an adverse relationship [27].

Night shift work may increase the risk of overweight and obesity for nurses who work the shift for prolonged periods of time. Kim and others (2013) evaluated a cross-sectional Korean Nurses' Survey from October to December 2011 using a web-based self-administered questionnaire. A total of 5,287 shift workers and 4,702 non-shift workers were included in the sample. Findings indicated the overall prevalence of overweight/obesity (18.6%) and obesity (7.4%) increased significantly as shift work duration increased from the lowest to highest (P for trend <0.001). Among the current shift workers, subjects with the longer duration of shift work were more likely to be older ($P < 0.001$) and to have a higher BMI ($P < 0.001$). Those subjects were also more likely to have hypertension, diabetes, hyperlipidemia or breast cancer ($P = 0.003$, $P < 0.001$, $P = 0.003$, $P < 0.001$). Multivariate logistic regression analysis revealed no association between current shift work and BMI. However, after adjusting for potential confounders, the participants with the longest duration of shift work were 1.63 (95% CI, 1.22–2.17) times more likely to be overweight or obese than those with the shortest duration. The authors concluded that the duration of shift work was positively associated with prevalence of overweight and obesity in Korean nurses [28].

Zhao, Bogossian, & Turner (2012) assessed for an interaction between shift work and overweight/obesity on low back pain. The data used was derived from the Nurses and Midwives longitudinal population-based study from April 2006 –April 2008. A total of 938 low back pain-free nurses aged 21 – 67 years old were selected as the sample which included Australian and New Zealand nurses. Out of these nurses, 319 nurses (34%) developed lower back pain during the 2 year period. The investigators discovered that working shift work could increase their risk of low back pain by as much as 40%. After adjusting for confounders, shift workers were 1.15 times more likely to develop LBP (p=0.03). If the nurse was overweight or obese (p<0.001), the chances of developing lower back pain increased even more. Shift workers who were overweight or obese had a 61% increase risk of developing LBP compared to day workers. In addition, the nurses with LBP had a higher percentage of being divorced/separated/widowed than those who did not have LBP (p=0.01) [29].

Wan & Chung (2012) investigated ovarian cycle of 151 nurses at Chang Gung Memorial Hospital to determine if there was a relationship with shift work. All subjects were between the ages of 21-37 years old and had a normal Body Mass Index. The study lasted 14 weeks. The researchers concluded that work place (p=0.014) and work shift (p=0.048) were significantly related to ovarian cycle pattern. Nurses who worked emergent care units and wards had higher prevalence of irregular ovarian cycle pattern. In addition, approximately 53% of the nurses who worked rotating shifts exhibited an irregular ovarian cycle pattern [30].

Furthermore, Nojkov and others (2010) investigated the prevalence of irritable bowel syndrome by examining data from 399 nurses including 214 on day shift, 110 working straight night shifts, and 75 doing rotating shifts. The authors concluded that rotating shift nurses had a significantly higher prevalence of irritable bowel syndrome (p<0.01) and abdominal pain (p=0.001) compared to the day shift workers. Rotating shift nurses had a significant more prevalence of abdominal pain (p=0.003) compared to night shift group [31].

Lo and others (2008) examined blood pressure changes and recovery under different work shifts in a sample of 22 single nurses without children who worked in a 600 bed hospital in Taipei Taiwan. The study only lasted 6 days and consisted of an original sample size of 24 nurses, but two nurse dropped out of the study. Subjects were excluded from study if they had thyroid dysfunction, diabetes, hypertension, history of cardiovascular disease, a BMI >25, were pregnant, current smokers or taking any contraceptive pills or sleeping pills. Within the sample 16 nurses worked rotating shifts and 6 nurses worked regular day shift within the outpatient clinic. Within the sample of rotating shift nurses, 8 worked in intensive care units, and 8 worked in the internal medicine ward. Each subject had 3 periods of 2-days of monitoring of blood pressures every 15 minutes during the daytime and every 30 minutes during the night time (arterial BP). Lo discovered that blood pressures that changed after evening shift usually returned to baseline on consecutive off-duty day after day shift, but they did not completely return to baseline after a night shift (p<0.05). Linear mixed-effect model showed that both systolic and diastolic BPs were significantly decreased during sleeping period and significantly increase while on working period, on a work day, but increased during sleeping period after a night shift or evening shift [32].

Burdelak and others (2012) examined a cross-sectional group of 725 nurses and midwifes (354 working on night shifts and 371 working only during the day) for an association between night shift work and the prevalence of disease in Poland. All of the nurses included in the study were between the ages of 40-60 and worked within the health care units located in Łódź, and the surrounding areas. The data was collected via interview utilizing the "Standard Shiftwork Index". The investigators adjusted for confounding variables

and then analyzed the frequency of disease conditions and the relative risk expressed as odds ratio. The authors concluded that there was no statistically significant increased relative risk of any diseases and conditions among the night shift nurses, compared to the day shift nurses. However, the duration of work performed on night shifts was significantly associated with an increase in relative risk (two times higher) of thyroid disease in women working 15 years or more on night shift (p trend=0.031). In fact, the frequency of thyroid diseases observed in the study population was two times higher than the frequency in the general population of Polish women (10%) [33].

Copertaro and others (2011) investigated if there is a relationship between shift work and select immune variables to include cortisol, immunophenotype, lymphocyte proliferative response, NK cytotoxicity assay, and human inflammatory cytokine assays for 68 shift workers and 28 daytime nurses at baseline and at 12 month follow-up. Multiple quantile regression analysis was used to estimate the effect of shift-work on stress and each immune system indicator. The investigators concluded that none of the variables studied differed significantly initially except for cytokines IL-1 beta and TNF-alpha which were lower in shift workers. At the 12 month follow-up, none of the variables studied were significantly different between the day and shift work nurses [34].

Chang and others (2014) investigated circadian changes and effects on mood, sleep-related hormones and cognitive performance for 23 off-duty nurses, 20 nurses working consecutive night shifts and 16 nurses working four consecutive night shifts in a rapidly rotating acute care hospital shift system in Taiwan. The sleep-related hormones measured in the study included growth hormone, cortisol, prolactin and thyrotropin. There were no differences in age, years of education, trait anxiety scores, mean total sleep time, sleepiness scores, mean sleep latency scores on the modified sleep latency test, growth hormone or cortisone levels among the three groups. According to the investigators, these scores indicated that there were no significant differences among the three groups in sleep propensity. Significant differences were identified for state anxiety scores ($p=0.009$), throtropin levels ($p=0.003$), prolactin ($p=0.003$), information processing index ($p=0.002$), symbol search test ($p=0.003$), digital symbol substitution test ($p=0.013$), and the latency portion of the Maintenance of Wakefulness Test ($p<0.001$) between the three groups. The ability to maintain wakefulness during the day decreased with longer periods of consecutive night work. The off duty group demonstrated better performance on perceptual and motor tasks than the night shift groups. The two night shift group demonstrated the highest level of state anxiety, poorer learning effect, poorer initial performance and higher prolactin levels. The authors concluded that rotating night shifts too quickly may cause anxiety and decrease attentional performance. In addition, the investigators proposed that rapid rotation of night shifts may also impact prolactin levels after night shifts [35].

IV. Discussion

There is a growing body of knowledge that supports the theory that night shift work may increase negative health risks for nurses. Some authors hypothesize that the negative effects of long term night shift work may be impacted by the circadian disruption, sleep deprivation, and melatonin suppression. This chronic disequilibrium may contribute to the negative health risks that appear to increase with the number of years of working on the night shift. Takahashi and others (2014) recommends health surveillance for all shift workers be conducted on a regular basis. Japan requires health evaluations twice a year for shift workers [36].

One of the most studied areas of health risks associated with nurse night shift work is breast cancer. Studies published over the last 10 years support an association between breast cancer risk related to night shift work with US and Danish [23] and flight attendants from Norway, Finland Sweden, Denmark, and Scandinavia [24]. Several investigators conducted systematic reviews of studies that examined the relationship between night shift work and breast cancer. The investigators report mixed opinions on the degree of the association between night shift work and breast cancer. Wang and others (2011) reported that the evidence is suggestive but not conclusive that night shift work is negatively associated with the development of breast cancer [28]. Kamdar and others (2013) reported that the evidence of an association between breast cancer and shift work was weak due to a failure to account for confounding variables in the study analysis [25]. The authors failed to find any dose-related relationship between night shift and breast cancer [25]. However, the literature review supports that there is a weak to moderate relationship between night shift work and breast cancer. No study was found within the last 10 years that suggested the level of evidence supports a direct causal relationship between shift work and breast cancer.

Other health risks associated with night shift work include increased risk of obesity [2, 15, 29, 30], Type II diabetes [2, 3], lung cancer [4], menstrual irregularities [8, 31], stroke [9], fractures [12], hypertension [15], thyroid disease [31], and cardiovascular disease [16]. These risks might be associated with poor dietary habits, such as increased amounts of calories and sugary foods which tend to increase fatigue and weight gain. In addition metabolic changes can occur when eating during the night shift. There is an increased incident of GI complaints. These health issues might be compounded by sleep deprivation or the development of a sleep disorder. Asaoka and others discovered that 24.4% of 1202 Tokyo nurses met the criteria for shift work disorder. Shift work disorder is associated with difficulty adjusting to sleep cycles around shift changes. The authors reported that nurses with shift work disorder spent more time working at night, experienced more depressive symptoms and had greater rates of accidents and errors [37].

On the other hand, night shift work has been identified as having a potentially protective effect for disease conditions such as Parkinson's Disease [13] and skin cancer [5]. The reduction in skin cancer may be related to the reduction in sun exposure for night shift nurses who may sleep during the daytime [5]. Parkinson's Disease has been associated with

length of sleep. Several studies report that night shift nurses may actually sleep shorter periods of time than day shift nurses. This reduction in sleep time has been hypothesized as to providing the protective factor of night work for Parkinson's Disease [13].

It is very clear that night shift rotations can increase the physical and emotional stress on nurses. With the identification of many potential health risks associated with long-term rotating night shift work for nurses, there is a strong need to identify strategies that can mitigate some of the health risks. Some nurses seem to not only manage night shift rotations but to thrive in the night shift environment. What are the characteristics of these nurses that help them to successfully navigate through the challenges of shift rotations? Future research should focus not just on identifying the health risk problems, but on developing preventive and health promotion solutions.

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AUTHOR'S PROFILE

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